Space Weather Technical Forecast

Issued on Tuesday, 30 May 2023 at 13:05 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated R1/R2 radio blackouts throughout. Increasing chance of Active electron fluence into the period. Slight chance of isolated G1/Minor storm intervals Day 2 onwards.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24hrs with peak flares of M1.2 and M1.8 recorded at 30/0810UTC and 30/1022UTC respectively, both from the departing AR3310 on the southwest limb. There are currently 9 numbered sunspot regions on the visible disc and1 unnumbered region. AR3315 (Eko/Beta-Delta-Gamma) remains the largest region, stabilising slightly in recent hours, but a very small delta spot remains visible within its trailing group. AR3317 and AR3318 in the northwest of the disc also saw some simplification. AR3310 (Hsx/Alpha) has recently passed beyond the western limb but has been active in recent hours, as recorded above. AR3220 (Cso/Beta) and AR3221 (Hsx/Alpha) recently numbered in the southeast are gradually rotating across the eastern limb. The other numbered regions are relatively small and simple with only small changes in recent hours.

No Earth-directed CMEs were observed on available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 have remained at generally ambient levels 350-400 km/s. Density has been below average (<5 ppcc). The total interplanetary magnetic field strength has been weak, at or below 6 nT with a slowly rising trend from 29/1800UTC, perhaps as a result of weak CME influence. The north-south component has weakly fluctuated between +6/-4 nT but predominantly positive from 29/1800UTC. The phi angle was negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at background levels throughout. High energy electron flux (greater than 2MeV at GOES-16) also remained at background to moderate levels. The associated 24 hour fluence has been below Active (above 1e8 integrated pfu). Electron fluence observed at 30/0000UTC was 7.15e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low to Moderate. A chance of isolated M-class flares and an ongoing slight chance of an X-class flare is maintained through the period.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently forecast but the potential of a glancing blow from a CME that left the Sun on 26 May into Days 2-3 (31 May-1 Jun), although much of this feature is directed southward.

Solar winds are likely to be remain ambient or slightly elevated levels. A HSS from coronal hole CH08/+ in the south of the disc, and a possible CIR ahead of it, expected to influence conditions from Day 3 or 4 (1-2 Jun). Geomagnetic activity is expected to be mainly Quiet to Unsettled

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though Day 1 (30 May). A chance of Active intervals from Day 2 (31 May) onwards, with a slight chance G1/Minor Storms. Firstly due to possible CME impacts into Day 2 (31 May), followed by potential connection to either a CIR and/or HSS from CH08/+ into Days 3 or 4 (1-2 Jun).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, however there remains a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to remain largely below the high threshold but with an increasing chance of reaching High levels during the diurnal maximum. An increasing chance that Electron fluence values may return to above the Active (1e8 integrated pfu) threshold into the period, but there is low confidence due to uncertainty of modifying factors and poor model guidance.

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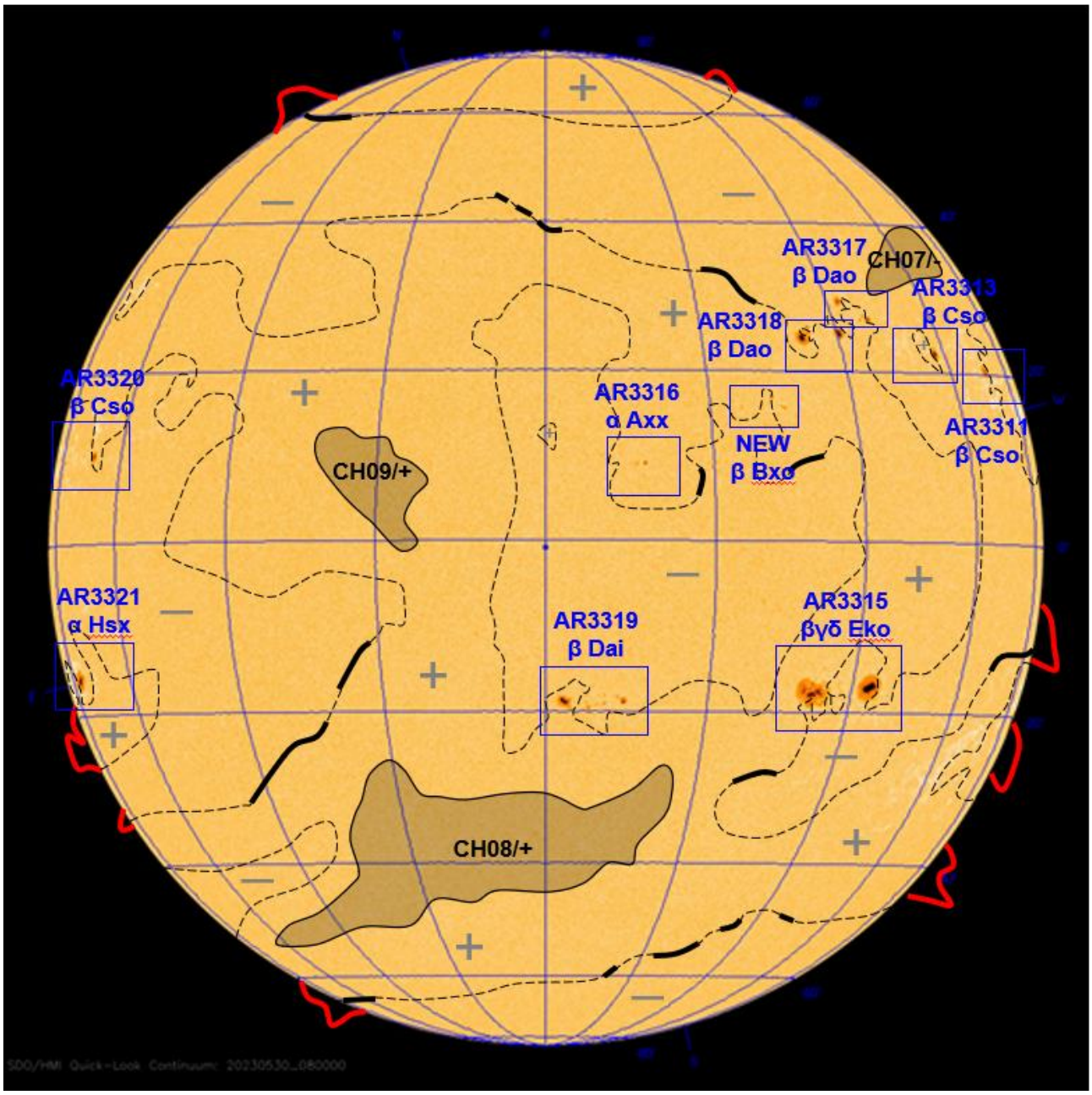
Figure 1. Solar Analysis Valid 30/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
No Earth-directed CMEs have been observed on available imagery over the past 24-hours. However, a number of Enlil ensemble members support the arrival at Earth on Day 2-3 (31 May-1 Jun) of a glancing blow from a CME that left the Sun on 26 May, although much of this feature is directed southward.

Solar winds are likely to be remain ambient or slightly elevated levels, perhaps with a slight but waning enhancement from a possible weak CME influence. A HSS from coronal hole CH08/+ in the south of the disc, and a possible CIR ahead of it, is expected to influence conditions from Day 3 or 4 (1-2 Jun). Persistence would suggest that the high speed stream may result in peak speeds of around 500km/s, although currently ENLIL forecast output suggest that the bulk of this stream will pass to the south of the Earth.

Geomagnetic activity is expected to be mainly Quiet to Unsettled though Day 1 (30 May). A chance of Active intervals from Day 2 (31 May) onwards, and a slight chance G1/Minor Storms. Firstly due to possible CME impacts into Day 2 (31 May), followed by potential connection to either a CIR and/or HSS from CH08/+ into Days 3 or 4 (1-2 Jun).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	10	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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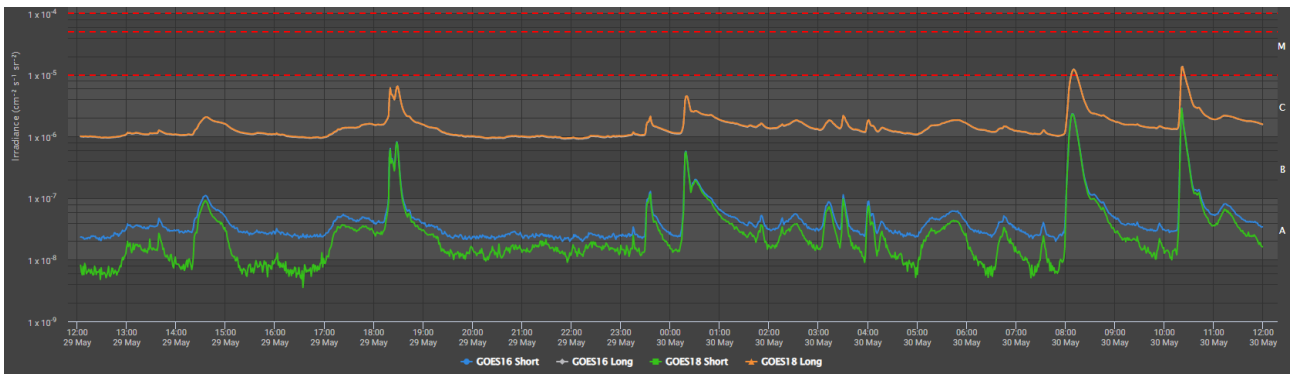
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate over the last 24hrs with peak flares of M1.2 and M1.8 recorded at 30/0810UTC and 30/1022UTC respectively, both from the departing AR3310 on the southwest limb.

There are currently 9 numbered sunspot regions on the visible disc and1 unnumbered region. AR3315 (Eko/Beta-Delta-Gamma) remains the largest region, stabilising slightly in recent hours, but a very small delta spot remains visible within its trailing group. AR3317 and AR3318 in the northwest of the disc also saw some simplification. AR3310 (Hsx/Alpha) has recently passed beyond the western limb but has been active in recent hours, as recorded above. AR3220 (Cso/Beta) and AR3221 (Hsx/Alpha) recently numbered in the southeast are gradually rotating across the eastern limb, as these regions rotate further onto the disc the improved viewing angle will result in more confident classification.. The other numbered regions are relatively small and simple with only small changes in recent hours. Due to the complex nature of some of the active and developing regions, a chance of further isolated M-class flares and an ongoing slight chance of an X-class flare is maintained through the period.

Several regions, some of which may have been responsible for significant activity as they tracked across the far-side, are due to rotate onto the eastern limb towards the end of the forecast period and are expected to maintain solar activity.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	40	40	40	40
Very Active	**R3 to R5 X Class**	No	10	10	10	10

Figure 2: Latest 24hr GOES18 X-Ray Flux



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and expected to remain so. A slight chance of S1/Minor Radiation Storming is maintained should any larger flares occur. AR3315 remains the most likely source region in the near term as it continues to transit the southwestern hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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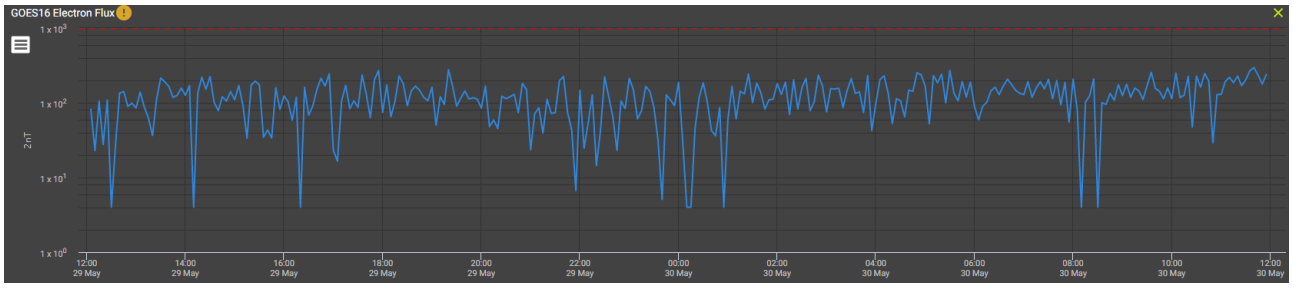
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been at Background to Moderate levels. Through the period it is increasingly likely to return to High levels during the diurnal maximum in the absence of any modifying factors, particularly later in the forecast. The most likely source of any geomagnetic activity is from a CME on Days 2-3 (31 May - 01 Jun), although this is expected to largely pass below the Earth, resulting in limited geomagnetic activity. There is a chance that a coronal hole HSS may connect at Earth on Day 3 or 4 (01-02 June) which may act to suppress the observed flux levels.

Associated 24 hour fluence is expected to generally show an increasing trend, with an increasing chance of breaching the Active (1e8 integrated pfu) threshold into the second half of the period (01-02 May) in the absence of significant geomagnetic activity. However, there is low confidence in the forecast, with REFM showing a large spread in possible fluence values and offering poor guidance. The increase in probabilities later in the forecast reflects the uncertainty with geomagnetic activity and the charging and relaxing of electron belts during the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Latest 24hr GOES16 Electron Flux



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